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ABSTRACT

A study of collaboration and the ongoing negotiation of authority in police helicopter work focused on inflight communication in one helicopter during two weeks of operation. Data were drawn from audio and video recordings of internal and external communications obtained inflight and from observation and physiological indicators of stress and workload. The factors observed included the official relationship of the crew members, the physical organization of the task and setting, the organization of information available to the subjects, the social organization of the work setting, and the collaborative nature of the work. Language use aspects examined included evidence of crew hierarchy, teasing, rates of initiation of non-operationally relevant new topics by each crew member, mitigation levels, and requests for information. Analysis of the data suggested that while there was evidence of the social hierarchy in the helicopter, the language of the speakers was not entirely predictable by their positions in that hierarchy, but reflected momentary changes in their relation to each other, dictated by changes in the task situation. Implications for other collaborative work settings were found in these results, and further research on authority negotiation in collaborative work settings was recommended. (MSE)

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WHO'S IN CHARGE HERE?: COOPERATIVE WORK AND AUTHORITY NEGOTIATION IN POLICE HELICOPTER MISSIONS

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1. Introduction

It is widely believed that in most work organizations, at least most well functioning organizations, the status of participants is fixed, usually in a hierarchical pattern. In this very common model, an organizational chart is considered to be as useful, as real, and as unproblematic as a circuit diagram. The purpose of this paper is to bring this assumption into question, by examining a cooperative work situation in which the authority status of the two participants is subject to a moment to moment negotiation, on the basis of whose task is most immediately salient, who has the knowledge to direct that task, the distribution of information resources, and the organization of the physical space. This negotiation is not, as conventional wisdom would predict, disruptive to successful completion of the task, but rather functions as a normal, unremarked background condition of ongoing daily operations. Further, it is suggested that this type of negotiation is not peculiar to this situation, but is a common and important part of all collaborative work. Finally, the understanding of the ongoing negotiation of authority is relevant not only to the understanding of current work situations, but is extremely important for the design of automated systems which are intended to augment or replace the activities of one or more participants in a complex work setting.

2. The Field Setting

The present study uses as data audio and video recordings obtained inflight during two weeks of operation of an airborne law enforcement agency. The aircraft is a Bell Long Ranger helicopter, which carries a flight crew of two: a pilot, who is the aircraft commander, and a flight officer, who is the mission commander. Pilots are generally former military pilots, who have received police training. Flight officers are police officers who have received paramedic training, but are not trained as pilots. Note that unlike most military and commercial aviation operations, this situation involves two parallel hierarchies of command rather than a single hierarchy. The pilot is responsible for all decisions include operation of the aircraft, and aircraft safety. The flight officer is in charge of the actual police mission. Typical missions include search and rescue, emergency

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medical services, suspect pursuit, fire spotting, transportation of personnel to crime or disaster sites, etc.

Several weeks of day and night operations were recorded using a stationary-mount video camera focused to show the backs of the heads of the crew members, the cockpit panel, and some of the crewmembers' view out the windshield. In addition, a voice recording system recorded both internal and external communications directly from the officers' communication lines, although only internal communications are analyzed in this study. In addition, subjective ratings and physiological (heart rate) measures were taken, to evaluate the effects of stress and workload on crewmembers.

This research site is of interest for a number of reasons. One is that although there are only two participants during each flight, the social structure is actually quite complex, and changes from moment to moment, depending on the nature of the task in focus. This provides an important contrast to situations previously investigated, such as commercial aviation crews (Linde and Goguen (1983), Linde (1988)). These crews have a much simpler, traditionally hierarchical structure. Additionally, the current situation provides a valuable site for the study of the nature of cooperative work, since the task demands vary widely in nature, predictability, and difficulty, and within a single mission, can range from so high that all the crewmembers' attention and capacity is required, to so low that that long periods of free conversation are possible.

This paper is based on investigation of the nature of cooperative work in four missions, but uses as its major example one short , successful mission in which an extremely high degree of collaborative effort is required. This mission, Flight 8, is a day shift mission, lasting from 1:05 to 1:37 p.m. The crew members had flown one mission previously during that shift, that lasted from 8:40 to 11:30 a.m.. The mission investigated was a response to a robbery of a VCR with a concealed micro-transmitter. The helicopter task was to use an on-board tracking device to follow the signal of the micro-transmitter, find the car with a path that matched the signal, establish the location of the car, and direct ground units to the car. This is an impressive array of task demands, especially since the crewmembers and ground units did indeed accomplish this mission successfully. This mission is additionally interesting because the flight officer, whose responsibility it is to direct the tracking task, was not familiar with the operation of the tracking device, since he had been filling a desk job for a year, and had just returned to flight duty. Therefore, the pilot had the additional responsibility of tutoring the flight officer on the operation of the tracking device in real time, as they attempted to carry out their actual mission. It is striking that the pilot was able to accomplish this potentially socially disruptive task with great skill, while continuing to fly the aircraft in a heavily trafficked air space. Three other missions, which involve performance of a variety of more routine

police missions, are studied as well, to provide a contrast to this unusual situation.

3. The Organization of the Task

3.1 The Physical Organization

Let us consider the effect of the physical layout of the helicopter on the organization of collaborative work. The two participants normally sit side by side in the front of the cockpit, the pilot on the right and the flight officer on the left. (The exception to this comes when they have picked up a victim of an accident or illness who must be transported on a stretcher. The stretcher is placed on the left side of the cockpit and extends into the front. When a stretcher is place, the flight officer moves to a seat in back of pilot, which has a duplicate set of radios for him to use.) Each crewmember has a view out the windshield, and the window in the door on his side. The space of the cockpit is small, filled to capacity with equipment, and densely used. Each crewmember has the controls for his radio in front of him, and stores his written materials on his side of the cockpit. However, the nature of the search task often requires joint use of maps, which means a shared use of physical space.

3.2 Organization of Information

The different information available to each crewmember also forms an important part of the structure of the collaborative work of this task. As discussed above, the two participants have had different specialist training, and therefore have different bodies of information available to them. Additionally, each crewmember has the task of monitoring a different set of radio frequencies: the pilot communicates with air traffic control agencies, the flight officer with police dispatch and other law enforcement and public safety agencies. The radios are set up so that each crew member may monitor several frequencies. Commonly the pilot will have the police dispatch frequency tuned in as a secondary channel and will give it some attention, but still depends on the flight officer to monitor it authoritatively, and will check what he thought he heard on that channel with the flight officer.

The flight officer also has street maps and topographical maps of the area, and it is his task to identify the area over which they fly, and match streets and landmarks to named locations on the map. This task frequently becomes collaborative, with both crewmembers consulting the map and attempting to match it to what they see.

3.3 Social Organization

In order to show the operation of authority negotiation, we must first determine what the social organization is in this situation. As is extremely common in almost all social

structures, there is an official and an unofficial organization. (This is a familiar distinction in ethnography. First people tell you how things work, and then, after hours, or days or years, if a good rapport has been established, they will tell you, or it will become evident how things *really* work.) In this law enforcement agency, officially, the two-man crew consists of two equals, both policemen, who both hold the rank of officer. As mentioned above, the pilot is the aircraft commander, responsible for the safe operation of the mission, while the flight officer is the mission commander, responsible for the completion of the police mission. This should, and in some respects does, mean that there are two hierarchies of command, either one of which may become salient depending on the demands of the moment. That is, piloting the aircraft or executing the police mission may be driving the crew's behavior at any moment, and thus may determine who has the right to give orders.

However, in practice, there are a number of types of evidence which show that in a situation in which there are no overriding task demands, the pilot tends to be treated as the commander, and the flight officer as the subordinate. Perhaps most importantly, while both crew members are paid more than ground-based officers, the pilot's supplement is higher. Thus, the pilot receives additional skill pay of 17% of his base salary, while the flight officer receives 5%. This is important evidence, since in American society it is axiomatic that rank, importance, and pay co-vary. (Historically, this difference dates from a period in which the pilot, of course, had training and skills as a pilot, but the flight officer had no additional training. Although flight officers now receive paramedic training, the difference in rate of skill pay has not changed.)

Another indicator that the two positions are not equal is the nature and direction of teasing and banter. In this social situation, teasing and banter are quite frequent, particularly because crewmembers can spend a great deal of time together at headquarters, waiting to be called out on a flight. A study was conducted of teasing, in which I wrote down all instances of teasing I heard during the second half of the study. (Note that the presence of an investigator, particularly a female investigator, is likely to have had an influence on the type of language used in teasing, and on the subjects of teasing. However, there is no reason why it should effect the direction of teasing.) I found that in this situation, teasing is almost always initiated by the superior. The subordinate may then tease back, but does not initiate a teasing round. This claim may appear to be circular, since the relative ranking of the pilot and the flight officer is the point at issue. However, the situation is clear in cases in which the sergeant is present, since he is officially and in fact the superior of everyone else present. It is always the sergeant who initiates any teasing round in which he is involved. Since we also see that in a teasing round between pilots and flight officers, it is the pilots who initiate the teasing, we may conclude that this is another sign of their rank relative to the flight officers.

Some examples are given below.

1. [FO is putting creamer in coffee, Sergeant is watching]
   S: Why don't you drink your coffee like a man?
   FO: How about just chewing on some coffee beans?

2. [Pilot and FO are discussing Vitalogs. P is wearing it in leg pocket, wires coming out fly end of flight suit zipper, FO is wearing it in breast pocket, wires coming out of top end of flight suit zipper.]
   P -> FO: You look ridiculous.
   FO -> P: You look [Points, laughs]

An additional observation about the direction of teasing which supports the observation that the pilot is taken as the superior is that while flight officers are teased about poor performance of their jobs, we have not observed this kind of teasing of pilots. While it is understandable that flight officers would not care to question, even in jest, the competence of the pilots with whom they fly, this taboo itself creates a ranking of the two positions.

A further type of social evidence for the higher rank of the pilot is that pilots tend to make decisions for both parties. A common type of decision occurs when there have been no calls for the helicopter. The crew members have the right to decide to go out on patrol, and they may do so if they have not yet flown a sufficient number of hours on their shift that day. The question about whether to make this decision is always initiated by the pilot, and we have not seen any instances of flight officers refusing this suggestion. (Note that pilots occasionally may refuse to answer calls, if they consider that they are too fatigued to fly safely.) Similarly, it is the pilot who decides when to conclude a mission.

Finally, we may note the interaction of the two crew members in terms of conversational management. During periods with a high workload, of course, the conversation is managed essentially by the demands of the task. This often includes, most saliently, near-continuous transmissions by both crew members on a number of radio frequencies. However, during periods when the workload is lower, for example, when the mission is completed, during the return flight to base, non-operationally relevant, social conversation does happen. Such conversation is not continuous; it is sporadic, interrupted both by radio transmissions, and by interspersed periods of silence. One common way to start conversations in this situation is to use "noticings", a form of conversational opening in which one party draws the attention of the other to some feature of the landscape as a potential conversational topic. (Moerman 1988) Examples of such initiations of non-operationally relevant conversation, all of which follow a significant period of silence, are given in (3) through (5). (3) is a noticing, (4) is a resumption 0f a topic initiated before the flight, and (5) is a non-operationally

relevant comment on a police mission just completed.

3. FO: This reservoir or lake or whatever looks pretty full, huh?
   P: Yep

4. P: So you gonna uh look for another car or try to get that one fixed?

5. P: That guy was kinda calm nd cool for havin' just ripped down somebody.

   FO: Oh yeah

   P: Must be on drugs

   FO: Just dancin' around ya' know out there in broad daylight

   P: Drugs or crazy.

Noticings and initiations of non-operationally relevant new topics are more frequently initiated by the pilot than by the flight officer, as shown in Table 1.

Table 1: Initiation of New Topics

	Pilot	Flight Officer
Flight 6	15	8
Flight 8	3	1
Flight 10	1	1
Flight 12	8	2
Total	27	12

[Chi square = 5.03, df = 1, p = .02]

There is an operational explanation for this difference: although the police mission may be completed, the pilot still has the responsibility for safe operation of the aircraft as they return to base. Therefore, he can decide, more easily than can the flight officer, whether conversation is safe or desirable at any moment. This fact, though, tends to give additional authority to the pilot; not only does he control the aircraft, he may control the intra-cockpit interaction as well.

We may conclude that, all other things being equal, the unofficial authority structure ranks the pilot higher than the flight officer. However, as we will see, at any moment, this may change given the immediate demands of the task.

4. Collaborative nature of the work

4.1. The Task

Let us now consider the nature of the task for the main mission studied here. Before leaving headquarters, the crewmembers have been told that there has been a theft of a VCR with a concealed microtransmitter, and that the suspects have escaped in a black over gold Datsun. Their task is to fly to the area, get a signal on the tracker, match the movement of the signal to a car which also matches the description, identify the location of the car, and direct ground units to the car. None of the these tasks is trivial. The description of the car which they have received may be only partially correct, or entirely incorrect. (The information given by witnesses is often unreliable, a fact which which experienced police officers of course know. Therefore, they will tend to respond to cars or suspects that match only one of many attributes that have been reported. (Rubenstein 1973)) In this case, the car is reported to be a black over gold Datsun, and proves to be a gold Pinto.

Also, it is difficult to match the track of the lighted indicator dot on the tracker to the track of a car, particularly since in certain conditions, the signal lags behind the motion of the car being tracked. (6) contains the pilot's explanation to the flight officer of how the device works, a rather detailed explanation which he gives after the mission, on the return to headquarters

> 6. P: Oh yeah. The uh when it's doin' all that jumpin' around shit. (FO Yeah) You kinda generally steer it that way until you get that solid buzz and a good light. And it's kind of a guessing game until you get a real good strong signal on it and then once you get on the signal you start goin' around, you look and try to find a car that's going the same direction you're goin'. We were on that gold car twice. The gold car would turn and go this way and it would still show straight until we got maybe abeam the corner and then it would start comin' around.

Once the crew has identified a car whose track matches the track of the signal, it is still a nontrivial task to ascertain its location; the flight officer uses street maps and attempts to use landmarks to match what he sees, from a height of about 500 feet, with locations on the map. Finally, ground cars must be directed in such a way as to keep them out of the potential line of fire from the suspected car.

4.2 Requirements for Collaboration

There are a number of ways in which the two crewmembers are required to collaborate to accomplish this task. First, and most obvious is the geographical location task. The flight officer must determine the area to be searched from police dispatch on the radio, and relay this information to the pilot. At the pilot's request, he may also inform the pilot of the area over which they are flying, or may consult maps to determine the identity of the streets below them.

Identification of the suspected vehicle is also, of necessity, a collaborative task, since, as discussed above, neither crew member has a full view of the ground. Although tracking the vehicle is formally the flight officer's job, because of the need to get as full a view as possible, the pilot must also participate. This task requires a great deal of pointing, often with gestures that impinge into the other crewmember's space or touch his body. Additionally, the pilot must be aware of the general direction of any vehicle the flight officer is tracking, in order to position the aircraft in the most helpful way.

Finally, identification of the location of the suspected vehicle may be a collaborative task, as only one crewmember may be able to identify a street or location, based on his local knowledge of the area. (7) gives an example of this type of collaboration.

7. FO: Where are we at Mike?

P: Let's see that was Stockton Boulevard and we're about two blocks south of whatever uh that street the OJ's on. S- Stockton approaching Fruitridge say.

(Note that part of the ongoing task for these crewmembers is updating of spatial knowledge. During periods of low workload, a common topic of conversation is the identification of landmarks, buildings and terrain features, and changes in them.)

5. Effects of Negotiation on Linguistic Structure

In studying the social nature of ongoing collaboration, one extremely sensitive indicator is linguistic marking of politeness and indirection. This variable, termed **mitigation**, is defined by (Labov and Fanshel 1977): those linguistic devices which serve to make an utterance less direct, more polite, and less likely to cause offense. In this data, utterances are distinguished as high mitigated, low mitigated, or direct. (A value of aggravated is also distinguishable, but there are no instances in this data set.)

High Mitigation

8. P: Say I would get a map out Dave. Of this area.

9. FO: Well you want to widen out just a little bit.

10. [FO: Why don't we go uh
P: Out to that creek?]
F: Yeah I was going to say out maybe to the creek or even kind of the, not the the bridge line, but up in there a little ways, maybe kind of work back.

Low Mitigation

11. P: OK did they have a vehicle description?
[Mitigated way to get the flight officer to request a vehicle description.]

12. FO: You don't follow the light then?
[Mitigated form of direct request for information: "Do you follow the light?" Compare example 16.]

13. P: That's a good reading now. When you get a constant?

14. FO: I wonder if they have canine units up here.
[Mitigated form of direct request for information: "Find out if they have canine units up there" Compare example 16.]

Direct

15. P: Direct that unit toward the gold car.

16: FO: Does it always bounce around like that?

As these examples show, there are many linguistic devices which function as mitigators: questions are more mitigating than imperatives; modal auxiliaries are more mitigating than simple verb forms; past tense forms where a present tense could be used are mitigating; negative questions are more mitigating than positive questions. This list could be continued almost indefinitely. A theory of why so many and such heterogeneous devices should all serve a similar social function has been given by (Brown and Levinson 1979). This account is based on the notion that politeness is the attempt to avoid **face threatening action**, where **face** is the public self-image that every member of the culture wants to claim for him/herself. There are two types of face, negative and positive. **Negative face** is "the basic claim to territories, personal reserves, rights to non-distraction -- i.e. to freedom of action and freedom from imposition." **Positive face** is the "positive consistent self-image or 'personality' (crucially including the desire that this self-image be appreciated and approved of) claimed by interactants." (p. 66) These two types of face give rise to two types of politeness, also called negative and positive. **Negative politeness** attempts to minimize the degree of trespass to the addressee's autonomy; **positive politeness** attempts to minimize the distance between speaker and addressee, so that the speaker's and addressee's desires appear to be the same.

In order to subject the use of mitigation to a quantitative analysis, it is necessary to devise a scale to quantify degrees of mitigation. We use a four-point scale: Aggravated, Direct, Low Mitigated, and High Mitigated. Direct utterances are assigned a value of 0, low mitigated utterances a value of 1, high mitigated utterances a value of 2, and aggravated utterances, (which are not present in this data), a value of -1. This scale has been empirically validated as conforming to the intuitions of the aviation community. That is, a reliability study was conducted, comparing sample utterance ratings of professional to ratings by the investigators, and found that the two sets of ratings were correlated at an 80% level. This study is described more fully in Linde and Goguen (1983).

Previous research (Linde and Goguen, 1983; Linde, 1988, Linde *et al* 1987) suggest that utterances going up the chain of command tend to be mitigated, while those going down the chain of command tend to be direct. Although this pattern has been found in situations such as commercial aviation crews, which have a strict and simple chain of command, it is not true in the case of the police helicopter crews, which have, as we have shown, a more complex situation of parallel hierarchy. Table 2 shows the mitigation scores for crew members in the four crews investigated. The mitigation score is computed by adding the numbers of Direct, Low mitigated, and High Mitigated utterances multiplied by 0, 1, and 2 respectively, and diving by the total number of utterances. Although the Flight Officers do have mitigation scores slightly higher than those of the Pilots, the difference is not statistically significant.

Table 2: Mitigation Scores of Crew Members, 4 Flights

Speaker	D	LM	HM	Mitigation Score
Pilots	47	39	3	.50
Flight Officers	55	43	7	.52

However, as we shall see, although mitigation is not used to mark stable hierarchical structure in this situation, it is used to mark negotiations of who is immediately in charge in a given situation. As we have seen, there are two parallel authority structures, defined by the task demands of the moment. The pilot is the aircraft commander, while the flight officer is the mission commander, and at any moment, the demands of one of these these aspects of the total mission may be most salient. Therefore, at any given time, a crew member may need to make a request of the other -- either to perform some action, or to ascertain or transmit some information. A request may be categorized by its task ownership -- an action needed for the

performance of the speaker's task, or for the performance of the addressee's. As we shall see, these have a very different social status, depending on whether one crewmember is telling the other how to do his own task, or requesting some action which he himself needs for his performance.

In the present investigation, we consider all requests, including requests for action, and requests for information. Requests for information may be, indirectly, requests for action, if the addressee does not have the requested information, and must perform an action to obtain it. We may further subdivide requests into requests pertaining to the speaker's primary responsibility, those pertaining to the addressee's primary responsibility, those pertaining to mutual responsibilities, that is, responsibilities of the entire mission, and those pertaining to no responsibility, that is, requests involving non-operationally relevant topics. We find that crew members are extremely sensitive to the nature of task demands: requests involving the speaker's own mission tend to be quite direct, while those involving the addressee's mission, tend to be significantly more indirect. This finding is quite understandable: requesting someone to perform his own task is potentially more face-threatening than requesting him to perform some action needed for one's own task. Note that in general, it is the pilot's task to pilot the aircraft, and it is the flight officer's task to identify people, cars, and places on the ground and to communicate with the police dispatcher. It is both crewmembers' task to find streets and major landmarks. (17) through (25)are examples of the range of direct, low mitigated, and high mitigated requests for tasks owned by the speaker and addressee. Task owned by both crewmembers or neither are not considered in this investigation, since they do not play a part in authority negotiations.

Direct -- Speaker's Task

17. FO: Did you see anything leave?

18. FO: Turn a light on.

Direct -- Addressee's Task

19. P: Do you see him?

20. FO: Come in a little closer right about at an angle like this.

Low Mitigated -- Speaker's Task

21. FO: See there you go again. [Pointing to tracking device]

22. FO: You don't follow the light then?

Low Mitigated -- Addressee's Task

23. P: So that's Kirby. Right there right?

24. P: I wonder if this high school parking lot would have anything though?

High Mitigated -- Addressee's Task

25. FO: We should monitor that um county fire if you don't mind.

Table 3 shows the comparison between speaker-oriented requests and addressee-oriented requests.

Table 3: Mitigation Level By Task Orientation

Task Ownership	D	LM	HM	Mitigation Score
Speaker	15	7	1	.39
Addressee	24	33	6	.71

[Chi square = 17.67, df = 1, p = .00002]

These results suggest that speakers' language is not wholly predictable by their position in a long-term social hierarchy. Rather, we see that momentary changes in their relation to one another, dictated by changes in the task situation, also affect their linguistic choices.

6. Implications for other work settings

It might be argued that this is an extremely unusual situation, with no implications for other work settings that are organized in a more conventional hierarchical structure. However, I would argue that in fact this situation is unusual only in that the official account of status is that the two crewmembers are equals, while the informal ranking is not. In many, if not all work settings, there are formal hierarchies of authority, hierarchies of task knowledge, hierarchies of seniority and historical information, hierarchies of access to information and gossip, etc. At any moment, any one of these forms of ranking may become most salient, or may be negotiated to become most salient, and thus the relative status of participants may change. Additionally, of course, all of these forms of relative ranking may be manipulated by participants in order to attempt to improve their long-term standing, or other factors of their work situation.

We may take as another example a study of small group planning, using the Watergate tapes as data (Linde and Goguen 1978). In this situation, the formal hierarchical ranking of President Nixon and his advisors is extremely well-structured and clear. Although subordinates of course attempted to improve their own standing, as many of their memoirs testify ((Dean 1979), (Magruder 1974)), this type of negotiation was less common in formal meetings with the president than it was in informal smaller meetings. The president's management style in formal planning meetings also tended to encourage the emergence of task driven authority. His practice was to allow subordinates to prepare and present a complete or nearly complete plan before beginning to criticize or alter it. In this management style, during the period when a subordinate presents a draft plan, he has the floor, and so has a certain amount of control over the flow of planning, even though in terms of a formal organization chart, he may be the most junior person present. This type of discourse status of rights to the floor has only recently begun to be studied in detail (Tannen 1984)) but it is clearly relevant to the organization of collaborative work.

Further studies of a variety of work settings are necessary, in order to determine the extent and types of authority negotiation present, and their relation to collaborative work. The present study should serve to indicate the existence of this phenomenon, and its importance to the understanding of the nature of work. This is particularly relevant to the design of automated systems intended either to aid participants, or to replace some of them. For example, there is a great deal of interest in the area of aircraft design in the development of the automated cockpit, which would replace one crew member with an AI system. All proposals for such systems assume that the work of the crewmembers is partitioned and separate, and therefore, automating the work of a single crewmember will make it possible to replace him.[1] This takes no account of the highly collaborative nature of the work, as this paper demonstrates. It is important for system designers to realize that crewmembers are not in fact isolated units performing isolated task elements, but rather are in constant and intense communication and co-creation of their tasks and their knowledge of the world. Furthermore, any system design which assumes a fixed hierarchy either of participants or of task types will inevitably fall short of the actual complexity of the nature of this type of work.

Notes

1. The immediate interest in helicopter automation is in the area of military rather than civilian helicopters. However, the same kinds of collaboration we have found in civilian law enforcement missions are present in certain types of military missions, and therefore the same issues of system design are relevant. (See Linde and Shively, to appear.)

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